RESEARCH CIRCULAR 168 MARCH 1969

Economics of Short Cycle Sawtimber Production

R. W. SHERMAN

OHIO AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER
Wooster, Ohio

CONTENTS

* *

AGDEX 821-300/56 3-69-2.5M

Economics of Short Cycle Sawtimber Production

R. W. SHERMAN

INTRODUCTION

With the tremendous effect of compound interest costs in the production of timber, it is important to look into the possibilities of materially shortening the production cycle. Of the costs involved in a 100-year cycle, about 87 percent is incurred in the second half of the period.[1] For an 80-year cycle, 83 percent of the cost is incurred in the second half and for a 60-year cycle, 76 percent is in the second 30 years. These percentages could change slightly with varying planting and cultural costs in the early stages of the production cycle.

Only sketchy information is available concerning methods of materially shortening the production cycle. It is evident that much less production per year is necessary to meet expenses when the cycle is shortened.

At the present time when there is no shortage of sawtimber, except in the high quality grades, it is not a question of producing more lumber but rather one of producing more efficiently. The bulletin mentioned in the footnote below points out that timber production in southeastern Ohio, starting from planting, is difficult to justify as an economic venture on a long cycle basis.

Another reason for investigating the economics of shorter cycle timber production, perhaps with less urgency than that of reducing cost of production, is that of a possible shortage of lumber by the turn of the century. In a recent publication of the U. S. Forest Service (Forest Resource Report No. 17, published in 1965), it was predicted that by the year 2000 the demand for sawtimber will exceed growth by 16 percent annually with assumption of "recent levels of forest management."

Shortening the cycle of production, however, would not help solve a lumber shortage unless it were accompanied by higher production per acre per year. If a profitable production technique could be devised (such as a shorter production cycle), then it might be profitable to devote more acreage or more productive acreage to timber production.

An increase in forest acreage may be necessary to produce enough timber to meet projected demand. If demand develops as predicted, it might be necessary to use some land which is now cleared for crop production.

---

[1]Sherman, R. W. 1967. Economics of Sawtimber Production in Appalachia, Ohio. Ohio Agricultural Research and Development Center, Res. Circ. 152, p. 9.

This publication is concerned only with the effect of shorter cycles of tree production on net income, with various assumed yields and costs.

In a paper presented at the "Walnut Workshop" at Carbondale, Ill., in 1966, John Wylie, Assistant State Forester, Missouri Department of Conservation, reported the effects on growth of two pruning procedures on a 15-year-old walnut plantation. One part of the plantation had been trimmed to 12 feet and the other to 21 feet, resulting in a significant difference in diameter growth. The shorter boles increased in diameter 17.2 percent faster than those trimmed to 21 feet. Future performance of this plantation will be very informative. Further tests should be conducted on trees trimmed to the shortest acceptable log length to furnish information on growth patterns.

In the same article, Wylie cited a walnut tree with one 9-foot log which grew to 44-inch diameter in 67 years. This indicates that rapid diameter growth can be attained by pruning for shorter logs.

Table 1, adapted from Mr. Wylie's article, shows hypothetical growth based on the growth attained in the walnut plantation mentioned. The author used projected growth based on the past 15-year growth of the plantation trees. The 12-foot log trees are projected to gain .56 inches per year and the 21-foot log trees at the rate of .44 inches per year. This seems to indicate that if the trees were further restricted to one 10-foot log length, diameter growth would be even more rapid.

Wylie attached dollar values to the logs which could be harvested at the various ages. At all ages, the value of the 12-foot log was calculated to be far greater than the 21-foot log.

If the trees were further restricted in log length with faster diameter growth, the value and timber volume would be greater still. The 67-

TABLE 1.—Diameter and Log Volume with Assumed Future Growth Rate of a 15-Year-Old Walnut Plantation.*

	Trimmed to 12 Feet		Trimmed to 21 Feet	
Age (Years)	Diameter (Inches)	Log Volume (Board Feet)	Diameter (Inches)	Log Volume (Board Feet)
25	14.0	27	11.0	—
30	16.8	61	13.2	27
35	19.6	91	15.4	68
40	22.4	147	17.6	111
45	25.2	217	19.8	136
50	28.0	300	22.0	194
55	30.8	363	24.2	302
60	33.6	469	26.4	387
65	36.4	588	28.6	482

*Adapted from Table I, page 93, Black Walnut Culture, Walnut Workshop, Carbondale, Ill., 1966.

year-old tree which Wylie mentions with a 9-foot log with 44-inch diameter had about 10 percent more log volume than the 12-foot hypothetical log depicted in the table at 65 years. The value of this extra log volume would be considerable.

Considerable added expense probably would be necessary during the early years of the production cycle to make sure that trees were trimmed to a specific height and properly spaced. Forestry production people will have to determine necessary practices to assure rapid growth of short-log trees. It also is necessary to determine species most adaptable to such cultural practices. The value of the final product per unit is a major factor in determining which species to produce.

In growing good trees, only those species which are most likely to show a profit should be considered. Walnut must surely be the outstanding candidate for this purpose in the Midwest, where walnut does well.

In shortening the maturity cycle, the aim should be to reduce the cycle to the most profitable maturity age. Due to compounding costs, each year adds more cost than the previous year. So the value of each year's growth must be greater than the previous year by at least the added cost or it does not pay to maintain the forest area. Table 8 provides a guide to quantity of production necessary at various prices to pay costs. Only high quality logs could command the high prices necessary with yields which are within reasonable expectations.

COSTS

Costs considered here are intended to be reasonable estimates and the ranges shown include most possibilities.

Interest

Interest is figured at 4 percent compounded annually. Although interest rates are higher than this at present, the long-time experience of interest return would be nearer 4 percent than the present rate for liquid-type loans. Of course, if money were to be borrowed for the purpose of producing timber, the rate would be considerably higher. Adjustment in costs can be made in accordance with any interest rate to be applied.

For compound interest on a beginning investment, the interest cost at 5 percent would be 58.9 percent greater than at 4 percent at 40 years, 71.4 percent greater at 50 years, and 85.7 percent greater at 60 years. Accumulated annual recurring costs with 5 percent interest would be 28.3 percent higher than with 4 percent interest at 40 years, 38.4 percent at 50 years, and 50.0 percent at 60 years.

TABLE 2.—Accumulated Interest Costs per Acre for Land at 4 Percent Interest (to Nearest Dollar).

Value per Acre	End of Year						
	30	35	40	45	50	55	60
$ 50	$112	$147	$ 190	$ 242	$ 305	$ 382	$ 476
75	168	221	275	363	458	573	714
100	224	295	380	484	611	765	952
150	337	442	570	726	916	1147	1428
300	673	884	1140	1452	1832	2294	2856

Land

Land costs in Table 2 are calculated on valuations of $50, $75, $100, $150, and $300 per acre. The higher values would probably apply only to land which is presently of significant value for general agriculture. Good quality land which has not been completely cleared for farming would not be valued at much over $100 until clearing costs are added. However, for walnut planting, $300 land would not be at all unreasonable at present walnut lumber prices shown in Table 10.

Tree growth would probably be more rapid on the better land but no adjustment was made for this since no data are available for the proposed cultural practices. The reader can easily make adjustments with different yield assumptions.

Land value is considered unchanged from planting to harvest time and nothing but interest is charged for the land. If cleared land were used, the end value might be less than at the start and again any assumed difference could be added by the reader.

Planting

These costs might vary from zero if voluntary seeding were possible to a comparatively high cost. The assumed costs of $10, $20, $30, $40, and $50 in Table 3 should cover most actual cases. Any costs between these steps could be easily interpolated accurately enough for general use.

TABLE 3.— Planting Costs per Acre Plus Interest at 4 Percent at End of Specified Years (Nearest Dollar).

Planting Cost per Acre	End of Year						
	30	35	40	45	50	55	60
$10	$ 32	$ 39	$ 48	$ 58	$ 71	$ 86	$105
20	65	79	96	117	142	173	210
30	97	118	144	175	213	259	316
40	130	158	192	234	284	346	421
50	162	197	240	292	355	432	526

TABLE 4.—Accumulated Costs of Cultural Care* per Acre Plus 4 Percent Interest at End of Specified Years (Nearest Dollar).

Accumulated Costs at End of 10 Years	End of Year 30	35	40	45	50	55	60
$ 10	$ 22	$ 27	$ 32	$ 39	$ 48	$ 58	$ 71
25	55	67	81	99	120	146	178
50	110	134	162	197	240	292	355
75	144	201	243	296	360	438	533
100	219	267	324	395	480	584	711

*Pruning, weed control, thinning, fertilization, etc.

Improvement Work

It is assumed that work of trimming the trees to desired log length and any other work required would be completed by the 10th year unless some minor weed control were desirable for a few more years, perhaps from the 10th to 15th years. Table 4 is figured from accumulated costs by the 10th year of $10, $25, $50, $75, and $100. Probably $30 would not be exceeded often but the higher costs are included for those cases where such costs might be involved.

If weed control is desirable for the years after the 10th, the accumulated costs of such work can be calculated easily. If any additional expenses are incurred for weed control and other cultural practices after 10 years, the expense would probably not add more than $50 per acre by the end of the 60th year. Such extra cost can easily be figured from time of occurrence to harvest by consulting interest tables.

Other Costs

This category includes fence costs, taxes, and fire prevention costs. These are calculated at $1, $2, and $3 as yearly recurring costs from the beginning of the planting (Table 5).

Based on the four expense tables (Tables 2, 3, 4, and 5), Tables 6 and 7 are constructed to show the range in costs per acre and per tree from lowest to highest combinations of assumed costs. Table 7, showing costs per tree, is based only on one density—60 trees per acre. For more or fewer trees per acre, the cost per tree can be adjusted accordingly.

TABLE 5.—Accumulated Annual Costs per Acre for Fencing, Taxes, and Fire Protection Plus 4 Percent Interest (Nearest Dollar).

Annual Outlay	End of Year 30	35	40	45	50	55	60
$1	$ 56	$ 74	$ 95	$121	$153	$192	$238
2	112	147	190	242	305	383	476
3	168	221	285	363	458	575	714

TABLE 6.—Lowest* and Highest† Costs per Acre at End of Specified Years (Nearest Dollar).

End of Year	Land Value per Acre									
	$50		$75		$100		$150		$300	
	Low	High	Low	High	Low	High	Low	High	Low	High
30	$222	$ 661	$ 278	$ 717	$ 334	$ 773	$ 447	$ 886	$ 784	$1223
35	287	832	361	906	435	980	582	1127	1024	1569
40	365	1039	450	1124	555	1229	745	1419	1315	1989
45	460	1292	581	1413	702	1534	944	1776	1670	2502
50	577	1598	730	1751	883	1904	1188	2209	2104	3125
55	718	1973	909	2164	1101	2356	1483	2738	2630	3885
60	890	2427	1128	2665	1366	2903	1842	3379	3270	4807

*Lowest cost for each land value is calculated by adding lowest level of costs in Tables 3, 4, and 5 to land cost.
†Highest cost for each land value is calculated by adding highest level of costs in Tables 3, 4, and 5 to land cost.

TABLE 7.—Lowest and Highest Costs per Tree at End of Specified Years (60 Trees per Acre).

End of Year	Land Value per Acre									
	$50		$75		$100		$150		$300	
	Low	High	Low	High	Low	High	Low	High	Low	High
30	$ 3.70	$11.01	$ 4.63	$11.95	$ 5.56	$12.90	$ 7.43	$14.77	$13.06	$20.38
35	4.78	13.87	6.01	15.10	7.24	16.33	9.68	18.80	17.06	26.15
40	6.08	17.32	7.66	18.90	9.25	20.48	12.41	23.65	21.92	33.15
45	7.66	21.53	9.68	23.55	11.70	25.57	15.73	29.60	27.83	41.70
50	9.61	26.63	12.16	29.20	14.71	31.73	19.80	36.81	35.06	52.08
55	11.96	32.88	15.15	36.07	18.35	39.27	24.71	45.63	43.83	64.75
60	14.83	40.45	18.80	44.42	22.76	48.38	30.70	56.32	54.50	80.12

To show the effect of growth rate, three rates of diameter growth are assumed for 10-foot log trees: 1/3 inch per year, 1/2 inch per year, and 2/3 inch per year. These rates seem well within growth possibilities based on the experience with the plantation mentioned by Wylie. Only tree species which will grow at least 1/2 inch should be considered for intensive short cycle management.

GROWTH AND PRICES NECESSARY TO DEFRAY COSTS

If profit is the purpose of timber production, the product, when marketed, must return more than all accumulated costs at time of harvest. The number of trees which can be grown per acre and the production per tree will decide the price necessary for production to be profitable. In a paper presented at the Walnut Workshop held in 1966 at Carbondale, Ill., John E. Krajicek recommended spacing walnut no closer than 26 feet for production of veneer logs. The number of trees which may be planted per acre (with a diamond shape spacing) is:

26 feet allows	74 trees per acre
27 feet allows	69 trees per acre
28 feet allows	64 trees per acre
29 feet allows	60 trees per acre
30 feet allows	56 trees per acre

Table 8 shows the board feet production per tree necessary at various prices per M.B.F. to meet or exceed assumed costs. Table 9 shows lumber production per tree with one 10-foot log at three growth rates. It is evident that rapid diameter growth is necessary to produce enough lumber to make production profitable. Statistics from the walnut plantation referred to earlier indicate that 2/3-inch diameter growth may be expected for walnut on favorable sites.

If no other acceptable species but walnut will grow at this rate, then the calculations shown in this publication apply only to walnut and only the higher prices shown in Table 8 have meaning. It is inconceivable that any but the more valuable species adapted to available land would be attempted where complete planting control is to be used.

Since rapid growth of sawtimber trees is so crucial to profitable production, it is probable that high quality, high priced land should be considered for such use. The only added cost in using the higher priced land would be in the compound interest cost for the value above lower grades of land which might be used.

Since walnut, because of its high value, seems to be the best candidate for production when considerable cultural costs are involved, it should be mentioned that most evidence points to the need for a specialized soil type for its growth. Referring to a study of growth on 120 plots of walnut throughout the Midwest, Willard H. Carmean reported

TABLE 8.—Necessary Yield in Board Feet per Tree to Meet Assumed Costs of Production at Various Prices per M.B.F. for Standing Timber at Specified Times.

	Land Value per Acre									
	$50		$75		$100		$150		$300	
End of Year	Low Cost	High Cost	Low Cost	High Cost	Low Cost	High Cost	Low Cost	High Cost	Low Cost	High Cost
					$40 per M.B.F.					
30	93	275	116	299	139	323	186	369	327	510
35	119	348	150	378	181	408	242	470	426	654
40	152	433	192	473	231	512	310	591	548	829
45	192	538	242	589	293	639	393	740	696	1043
50	240	666	304	730	368	793	495	920	877	1302
55	299	822	379	902	459	982	618	1141	1096	1619
60	371	1011	470	1111	569	1210	768	1408	1363	2003
					$60 per M.B.F.					
30	62	184	77	199	93	215	124	246	218	340
35	80	231	100	252	121	272	161	313	284	436
40	101	289	128	315	154	341	207	394	365	553
45	128	359	161	393	195	426	262	493	464	695
50	160	444	203	487	245	529	330	614	584	868
55	199	548	253	601	306	656	412	761	731	1079
60	247	674	313	740	379	806	512	939	908	1335
					$80 per M.B.F.					
30	46	138	58	149	70	161	93	185	163	255
35	60	173	75	189	91	204	121	235	213	327
40	76	217	96	236	116	256	155	296	274	414
45	96	269	121	294	146	320	197	370	348	521
50	120	333	152	365	184	397	248	460	438	651
55	150	411	189	451	230	491	309	570	548	809
60	185	506	235	555	285	605	384	704	681	1002

TABLE 8 (Continued).—Necessary Yield in Board Feet per Tree to Meet Assumed Costs of Production at Various Prices per M.B.F. for Standing Timber at Specified Times.

	Land Value per Acre									
	$50		$75		$100		$150		$300	
End of Year	Low Cost	High Cost	Low Cost	High Cost	Low Cost	High Cost	Low Cost	High Cost	Low Cost	High Cost
					$100 per M.B.F.					
30	37	110	46	120	56	129	74	148	131	204
35	48	139	60	151	72	163	97	188	171	262
40	61	173	77	189	93	205	124	237	219	332
45	77	215	97	236	117	256	157	296	278	417
50	96	266	122	292	147	317	198	368	351	521
55	120	329	152	361	184	393	247	456	438	648
60	148	405	188	444	228	484	307	563	545	801
					$200 per M.B.F.					
30	19	55	23	60	28	65	37	74	65	102
35	24	69	30	76	36	82	48	94	85	131
40	30	87	38	95	46	102	62	119	110	166
45	38	108	48	118	59	128	79	148	139	209
50	48	133	61	146	74	159	99	184	175	260
55	60	164	76	180	92	196	124	228	219	324
60	74	202	94	222	114	242	154	282	273	400
					$500 per M.B.F.					
30	8	22	9	24	11	26	15	30	26	41
35	10	28	12	30	15	33	19	38	34	52
40	12	35	15	38	19	41	25	47	44	66
45	15	43	19	47	23	51	32	59	56	83
50	19	53	24	58	29	64	40	74	70	104
55	24	66	30	72	37	79	50	91	88	130
60	29	81	38	89	46	97	61	113	109	160

TABLE 9.—Approximate Volume of Lumber per Tree with One 10-Foot Log at Three Growth Rates.

End of Year	Diameter Growth Rate					
	1/3 Inch		1/2 Inch		2/3 Inch	
	Board Ft.*	Cu. Ft.	Board Ft.*	Cu. Ft.	Board Ft.*	Cu. Ft.
			1/8-Inch Sawkerf			
30	40	5.4	90	12.2	170	21.8
35	55	7.4	130	16.7	240	29.6
40	70	9.7	170	21.8	315	38.8
45	90	12.2	225	27.6	410	49.1
50	115	15.1	280	34.1	510	60.5
55	140	18.4	345	41.2	620	73.3
60	170	21.8	410	49.1	740	87.3
			1/4-Inch Sawkerf			
30	36	5.4	81	12.2	154	21.8
35	50	7.4	118	16.7	217	29.6
40	65	9.7	154	21.8	285	38.8
45	81	12.2	204	27.6	371	49.1
50	104	15.1	253	34.1	462	60.5
55	127	18.4	312	41.2	561	73.3
60	154	21.8	371	49.1	670	87.3

*Adapted from Table 4 of A Guide to Hardwood Log Grading, Northeastern Forest Experiment Station, Forest Service, U. S. Dept. of Agriculture, Upper Darby, Pa., 1963.

at the Walnut Workshop in Carbondale, Ill., in 1966 that "best growth occurred on deep medium-textured soils that had loose, well drained subsoils."

This type of land has much higher value than that normally devoted to forestry. For this reason, Table 10 is constructed to show the cost of using land with values of $300, $400, and $500 per acre. To determine total production costs, the appropriate expenses shown in Tables 3, 4, and 5 must be added. It is apparent that with a growth rate of 1/2 or 2/3 inch per year, the costs are still well below present prices being paid for walnut logs, even with $500 land.

As with the production of any commodity, the question of investment is partly influenced by preference for liquidity. Even though the future profits are expected to be great, the risks involved in waiting for 30 years or more are discouraging to many investors. However, the discounted value of future income should make such investments desirable at all periods of time on the assumption that such value is recognized and a resultant market exists. For instance, if a walnut tree at 50 years of age will show $100 profit, its discounted value at 20 years would be about $30 at 4 percent interest, even though its value for lumber might be zero at 20 years. At this rate, the value of a walnut planta-

TABLE 10.—Land Cost of Timber Production at Three Growth Rates on High Value Land (60 Trees per Acre with One 10-Foot Log Each).

	Land Value								
	$300 per Acre			$400 per Acre			$500 per Acre		
End of	Diameter Growth			Diameter Growth			Diameter Growth		
Year	1/3 Inch	1/2 Inch	2/3 Inch	1/3 Inch	1/2 Inch	2/3 Inch	1/3 Inch	1/2 Inch	2/3 Inch
				Cost per Board Foot (Cents)					
30	31.1	14.0	7.2	41.4	18.9	9.6	51.8	23.3	12.0
35	29.4	12.5	6.8	39.2	16.7	9.1	49.0	20.8	11.3
40	29.2	12.3	6.6	38.9	16.4	8.8	48.7	20.5	11.0
45	29.9	11.9	6.5	39.9	15.9	8.7	49.8	19.8	10.8
50	29.4	12.1	6.6	39.2	16.1	8.8	49.0	20.2	11.0
55	30.0	12.3	6.8	40.0	16.4	9.1	50.0	20.5	11.3
60	30.9	12.4	7.1	41.2	16.5	9.5	51.5	20.7	11.8
				Cost per Cubic Foot					
30	$2.02	$ .93	$ .51	$2.69	$1.24	$ .68	$3.37	$1.55	$ .85
35	1.99	.88	.50	2.65	1.17	.67	3.32	1.47	.84
40	1.96	.86	.49	2.61	1.13	.65	3.27	1.43	.82
45	1.99	.88	.49	2.65	1.17	.65	3.32	1.47	.82
50	2.03	.90	.50	2.71	1.20	.67	3.38	1.50	.84
55	2.07	.93	.52	2.76	1.24	.69	3.45	1.55	.87
60	2.19	.93	.54	2.92	1.24	.72	3.65	1.55	.90

tion with such profit possibilities and 60 trees per acre would be $1800 at 20 years plus the value of the land. With fewer trees per acre, the value would be correspondingly lower.

The discounted value would increase each year and this is the "present value" which should determine the market value at any specified time. The owner of a partially grown tree plantation should be able to realize this discounted value at any time he wishes to sell the plantation. Such recognition of present value is important in influencing the establishment of a forest area. If the only value recognized is that at harvest time, a 40-year-old man can hardly be expected to plant an area to timber trees which will have little value to him for 50 or 60 years.

CONCLUSIONS

Conclusions based on hypothetical costs and returns are always subject to question. However, with experimental data lacking, there is only the opportunity to use synthetic data, to keep such data within reasonable possibilities, and to offer ranges which include most possibilities. It is hoped the data presented in this publication are within these bounds.

A previous study[2] showed that sawtimber production in Appalachia, Ohio, as normally practiced offers little hope of profit to the owner because of the great expense associated with the long periods required to bring trees to harvesting size. The alternatives are to shorten the growth cycle or to increase the value of harvested trees.

Calculation of assumed costs of short cycle production indicates that, if growth can be attained similar to that obtained in the walnut plantation in Missouri (page 4), production can be profitable for species of trees commanding premium prices.

If plantings are to be carefully controlled, there is no reason to plant anything but the most valuable species.

Land with value up to $500 per acre could be used if a diameter growth rate of 1/2 inch could be maintained with 60 trees per acre and if the logs could be sold for $250 per M.B.F. If 2/3-inch diameter growth could be maintained, the necessary price would be about $150 per M.B.F. Costs of growth on $300 land would be only 60 percent as much as on $500 land.

Walnut seems to offer excellent opportunities for short cycle timber production, especially if growth attained in the Missouri plantation mentioned can be attained on land which may be devoted to forestry.

The question remains whether timber can be produced profitably on land such as that in southeastern Ohio where forest land predomin-

---

[2]Sherman, R. W. 1967. Economics of Sawtimber Production in Appalachia, Ohio. Ohio Agricultural Research and Development Center, Res. Circ. 152.

ates. If trees will grow at only one half the rate on poor soil as on good soil, the cost saving with cheap land is not sufficient to offset the slower growth.

Much intensive research on short cycle sawtimber production needs to be undertaken on all grades of land and with several high value specics of trees to determine whether or not such cultural practices can result in profit. It is evident, however, that intensive culture of walnut on better soils would be profitable at present prices or even at much lower prices.

The State Is the Campus for Agricultural Research and Development

Ohio's major soil types and climatic conditions are represented at the Research Center's 12 locations. Thus, Center scientists can make field tests under conditions similar to those encountered by Ohio farmers.

Research is conducted by 13 departments on more than 6200 acres at Center headquarters in Wooster, ten branches, and The Ohio State University.

Center Headquarters, Wooster, Wayne County: 1953 acres

Eastern Ohio Resource Development Center, Caldwell, Noble County: 2053 acres

Jackson Branch, Jackson, Jackson County: 344 acres

Mahoning County Farm, Canfield: 275 acres

Muck Crops Branch, Willard, Huron County: 15 acres

North Central Branch, Vickery, Erie County: 335 acres

Northwestern Branch, Hoytville, Wood County: 247 acres

Southeastern Branch, Carpenter, Meigs County: 330 acres

Southern Branch, Ripley, Brown County: 275 acres

Vegetable Crops Branch, Marietta, Washington County: 20 acres

Western Branch, South Charleston, Clark County: 428 acres